



## Evaluation of Prevalence and Severity of Anemia among Non-pregnant women of Reproductive Age in Garmian Province, Iraqi Kurdistan Region

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### Abstract

Anemia is a major significant public health issue that affects both pregnant and non-pregnant women throughout the world. This study aimed to determine the prevalence and severity of anemia, as well as its classification, based on MCV values in non-pregnant women residing in the Garmian province in the east of Iraq. Blood samples were collected from non-pregnant women between the ages of 16 and 49 years. Anemia is classified as mild, moderate and severe, and as microcytic, normocytic and macrocytic depending on the level of Hb or mean corpuscular volume (MCV) respectively. In this study sociodemographic and hematological characteristics were also evaluated. The results showed that 56% of the study samples were anemic, and of the total anemic patients, 54 (35%), 86 (55%) and 16 (10%) had mild, moderate, and severe anemia respectively. Also, of the total anemic patients, 102 (65%) had microcytic type of anemia, 51 (33%) had normocytic anemia and only 3 (2%) had macrocytic anemia. The majority of anemic women (77.6%) had normal RBC counts but low Hct, MCH and MCHC values of 76.3%, 79.5% and 81.4%, respectively. The results showed also that there was no significant difference between the severity of anemia and age groups, occupation, blood pressure, bleeding, and haemorrhoids. However, diabetics showed a significant difference in anemia severity with <0.0004 P-value. The results showed that anemia had become a major public health issue in the study area.

**Keywords:** Anemia, Non-pregnant women, Hematological parameters, Severity, Iraq

تقييم انتشار و شدة فقر الدم لدى النساء الغير حوامل في عمر الانجاب في منطقة كرميان اكرديستان  
العراق

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### الخلاصة

فقر الدم هو احد اهم المشاكل الصحية العامة التي تؤثر على النساء الحوامل وغير الحوامل في جميع أنحاء العالم. تهدف دراستنا إلى تحديد مدى انتشار وشدة فقر الدم بالإضافة الى تقسيم فقر الدم حسب عامل ال MCV لدى النساء غير الحوامل المقيمت في محافظة كرميان شرقي العراق. عينات الدم قد جمعت من نساء غير حوامل تتراوح أعمارهن بين 16 و 49 سنة. تم تصنيف شدة فقر الدم الى ثلاث مجاميع (خفيفة ومتوسطة وحادة)، وايضا تم تصنيف فقر الدم الى (فقر الدم صغيرة الخلايا، وفقر الدم طبيعي الخلايا، فقر الدم كبير الخلايا). وقد تم ايضا تقييم الخصائص السلوكية الاجتماعية وخصائص الدم. اكثر من نصف النساء في هذه الدراسة كانوا يعانون من فقر الدم، ومن إجمالي العدد الكلي للمصابات، عانت 54 (35%) من فقر الدم الخفيف، بينما كانت 86 (55%) مصابات بفقر الدم المتوسط، و 16 (10%) مصابات بفقر الدم الشديد. وأظهرت النتائج ان 102 (65%) من النساء المصابات لديهم فقر الدم نوع صغير الكريات، و 51 (33%) لديهم فقر دم طبيعي الكريات، و فقط 3 (2%) كن مصابات بفقر دم نوع كبير الكريات من المجموع الكلي للمصابين بفقر الدم. كان لدى غالبية النساء المصابات بفقر الدم (77.6%) تعداد كريات الدم الحمراء طبيعياً ولكن قيم Hct، MCH و MCHC كانت منخفضة بنسبة 76.3%، و 79.5% و 81.4% على التوالي. أظهرت النتائج عدم وجود فرق معنوي بين شدة فقر الدم والفئات العمرية والمهنة وضغط الدم والنزيف والبواسير، لكن مرضى السكر أظهروا فرقا كبيراً مع شدة فقر الدم بقيمة احتمالية قدرها >0.0004. أظهرت النتائج أن فقر الدم أصبح مشكلة رئيسية للصحة العامة في منطقة الدراسة.

## 1. Introduction

Blood's ability to carry oxygen throughout the body is reduced when the quantity and volume of red blood cells (RBCs), or the amount of haemoglobin (Hb) falls below a certain cut-off value. This disease/condition is known as anemia [1]. At the population level, Hb levels are the most accurate indicator of anemia because they are generally cheap and simple to assess. According to the criterion of the World Health Organization (WHO) a non-pregnant woman is considered anemic if the Hb level is less than 12 g/dl. The severity of anemia for non-pregnant women is categorized by the WHO depending on Hb levels as mild (11.0-11.9 g/dl), moderate (8.0-10.9 g/dl) and severe anemia (Hb less than 8.0 g/dl) [2]. The prevalence of anemia was highest among pre-school children, pregnant women and non-pregnant women, whilst lowest among school-aged children, men and the elderly [3]. In 2009, anemia affected 41.8% and 30.2% of pregnant women and non-pregnant women worldwide [4]. According to the data from 2010 [5], there were more than 2.2 billion anemic individuals with a prevalence rate of 32.9% globally. Additionally, data from 2011 [6] showed that 38% of pregnant women and 29% of non-pregnant women aged between 15 and 49, had anemia. Data in 2020 showed the prevalence of anemia among women of reproductive age reached about 29.4%, and it affected around 40% of pregnant women and more than 20% of non-pregnant women worldwide [7]. Anemia is most common in Africa where 57.1% of the pregnant women and 47.5% of non-pregnant women are anemic, followed by Southeast Asia, where pregnant women and non-pregnant women (48.2%) and (45.7%) are anemic respectively [8].

Fifty percent of the causes of anemia in women are mainly due to a lack of iron [6]. Iron deficiency, which results from a negative iron balance for a long period, can be brought on by inadequate dietary iron and poor iron-rich food intake or problems with absorption, increased iron requirements especially during pregnancy and growth. Sometimes this deficiency is due to increased iron losses by menstruation and helminth (intestinal worm) infestation that eventually

leads to anemia. Infections and other nutritional deficiencies, particularly folate and vitamins (B12, A, and C), and genetic disorders (sickle cell disease, thalassemia, and chronic inflammation) are other significant causes of anemia. Severe malaria also frequently causes anemia which may be linked to a secondary bacterial infection. Anemia and iron deficiency have a number of negative effects on a person's health including fatigue and lethargy, impairment of physical capabilities and poor work performance. Many women's health and quality of life are negatively impacted by anemia, as are generations of children's learning and development, as well as the economic productivity and growth of communities and entire countries [1]. Many researchers have discovered links between anemia and biological, socio-economic, behavioural, educational, ecological, and political issues, in addition to diet and health status [1, 9-12]. One of the most important RBC parameters which are achieved by the complete blood count (CBC) analyzer is mean corpuscular volume (MCV) which is used as an indicator for the measuring the average volume of red blood cells. It can also be used to classify anemia (microcytic, normocytic, and macrocytic anemia). In microcytic anemia, the RBCs have an MCV is less than 80 femtolitres. While MCV is within established normal limits (80-100 fl) in normocytic anemia, Hb is lowered [13]. Anemia with an MCV of more than 100 fl is known as macrocytosis anemia [14]. We carried out this study because there was a lack of accurate information about anemia and its severity in women residing in the Garmian province in the Iraqi Kurdistan region. Our aim for this study was to scientifically determine the prevalence of anemia and the severity of the condition in non-pregnant women, as well as classify anemia based on the mean erythrocyte volume.

## **2. Method and Material**

### ***Study setting***

The study was conducted in the city of Kalar in the Garmian province of the Iraqi Kurdistan region. During the study, 294 blood samples were collected from 16–49 years old non-pregnant women who had attended the Garmian Medical City and Zanko Medical Laboratory between August 2021 and April 2022.

### ***Data collection***

The data collected was based on a questionnaire that was prepared to investigate the disease and sociodemographic factors, after the participants had agreed to be included in the study. Before handing out the questionnaire, the respondents were informed about the study and given instructions on how to provide accurate answers. The information included name, age, occupation, place of residence and the presence of the selected disease. Depending on age ranges, all participants were divided into three groups as following:  $\leq 29$ , 30-39, and 40-49 years. Again, the participants were also categorized into three groups based on the distribution of their occupations: students, housewives, and government employees. Additionally, all individuals were separated into four groups based on the existence of the following diseases: diabetes, high blood pressure, bleeding and haemorrhoids.

### ***Laboratory work and Differential value consideration***

Two millilitres of blood samples were taken from the median cubital vein and then stored in a special tube containing an anticoagulant of ethylenediaminetetraacetic acid (EDTA). CBC tests were conducted by a haematology analyser (Medionic M51, Sn: Tf11042111015, Sweden) from Zanko Medical Laboratory. The blood samples collected in Garmian Medical City were analyzed by a hematology analyzer (Swelab Alfa Plus, Sn:111684, Sweden). Anemia and its severity are defined according to WHO thresholds [2] as Hb levels below 12 g/dl in non-pregnant women being considered anemic. Anemia is categorized as mild in those with blood Hb level between 11-11.9 g/dl, moderate if the blood Hb level is between 8-10.9 g/dl, and severe

if the Hb level falls below 8 g/dl. Additionally, the study's findings were compared to how anemia in the community is classified by the WHO as significant for public health based on prevalence estimates derived from Hb level in the blood. Anemia has been divided into three categories based on MCV: microcytic (MCV lower than 80 fl), normocytic (MCV between 80-100 fl), and macrocytic (MCV higher than 100 fl) [13]. Additionally, RBCs levels, Haematocrit (Hct), Mean Cell Haemoglobin (MCH) and Mean Cell Haemoglobin Concentration (MCHC) at low, normal, and high levels were also measured based on the study by Al-Faris *et al.* [15].

### Statistical analysis

The percentage, mean, and standard deviation (SD) were statistically evaluated by using Microsoft Excel 2014 for the achieved data. Additionally, Chi-square test was used to determine whether there was a significant difference between the groups. P-value of less than 0.05 was considered for statistical significance level [16].

### Ethical Consideration

An ethical approval letter was obtained from the scientific and ethical committee of the Department of Biology, College of Education, University of Garmian. Each study participant was informed about the study objective and consent was obtained by all participants to contribute to this study.

### 3. Results and Discussion

A total of 294 non-pregnant women in the area of Garmian/Kurdistan region, Iraq of different ages 231 were from Kalar, 19 from Kifry, 24 from Rizgary, 7 from Bawanour, 7 from Girda Gozena, and 3 from Kulajoh were involved in this study. As shown in Table 1, 53% anemic women had a mean Hb of 10.14 and 47% non-anemic women had a mean Hb of 12.93. For the non-anemic women, the highest age group was ( $\leq 29$  years) with 44%, (40-49 years) with 29%, and (30-39 years) with 27%, while for the anemic women, the highest age group was (40-49 years) with (42%), ( $\leq 29$  years) with 30%, and the lowest age group was (30-39 years) with 28%. The majority of the participants were housewives.

**Table 1:** Prevalence of anemia among study samples (n=294)

Prevalence	Number of anemic non-pregnant women	Percentage	Mean of Hb (g/dl)	SD
Anemic	156	53	10.14	1.43
Non-anemic	138	47	12.93	0.71
<b>Total= 294 (100%)</b>				

Hb: Haemoglobin, SD: Standard Deviation

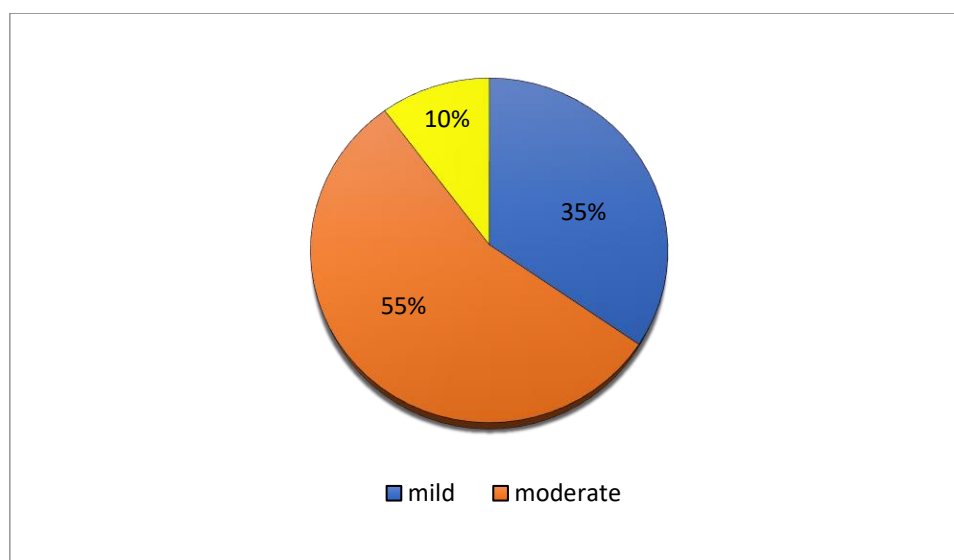
These results are similar to the results of the studies conducted on the prevalence of anemia among women of reproductive age in various countries including Gambia (50.3%) and India (49.9%). And the results of our study are lower than those achieved in Yemen (57.4%), but higher than the results achieved after the studies conducted in Senegal (47.3%) and Mali (47.6%) [17]. The results of the current study are similar to the prevalence of affected non-pregnant women shared by WHO with a value of  $\geq 40.0$  and considered to be severe to public health based on prevalence estimated from blood levels of Hb [2]. Same results were previously obtained in a study by Abdul Wahid and Ahmed [18] when they worked on the prevalence and severity of anemia in pregnant women. A high prevalence of anemia in non-pregnant women has been found in more than 50 countries, with public health significance. There were 53% women with anemia conditions. Anemia right now is a major world issue that affects both the developed and developing countries around the world. It can also affect both genders, but

women have a higher rate, especially pregnant women [8]. Study of Wu *et al.* [7] involved 640,672 participants, including both pregnant and non-pregnant women aged between 18–49 years, and of those, non-pregnancy included 351,980 participants. Out of the total study samples, 121,254 women were found to have suffered from anemia, with a prevalence of 18.9%. The prevalence of anemia in non-pregnant women was 17.4%.

As shown in Table 2 and Figure 1, the results reveal that of the total anemic non-pregnant women, 54 (35%) had mild anemia with an average of 11–11.9 g/dl, 86 (55%) had moderate anemia with an average of 8–10.9 g/dl, and 16 (10%) were affected by severe anemia with an average of <8 g/dl.

**Table 2:** Severity of anemia among anemic patients (n=156)

Severity of Anemia	Number of Anemic Non-pregnant Women	Percentage	Mean of Hb (g/dl)	SD
Mild anemia	54	35	11.47	0.3
Moderate anemia	86	55	9.88	0.8
Severe anemia	16	10	7.05	0.65
Total= 156 (100%)				



**Figure 1:** The distribution of the severity of anemia among anemic patients

The results of our study for severity of anemia contrast with the study conducted by Akbarpour *et al.* in Iran [19]. In their study, 30,506 adult males and non-pregnant females took part. Of the participants, 2,691 had mild anemia (69.02%), 1,135 had moderate anemia (29.11%), and 73 had severe anemia (1.87%). 2,143 (65.18%) of the non-pregnant study participants had mild anemia, 1,075 (32.69%) had moderate anemia, and 70 (2.13%) had severe anemia. And a study by Hyder *et al.* [20] showed mild anemia (52%), moderate anemia (20%), and similar to our results, a small percentage of them (1%) suffered from severe anemia. Somehow, the mild anemia results were similar to a study done in Lahore with a mild anemia estimate of 36.9%. According to Gardner and Kassebaum's analysis from 2019 on the severity of anemia globally, 54.1% of cases of anemia were mild, 42.5% were moderate, and 3.4% were severe [21]. The levels of moderate and severe anemia in Garmian province were higher than in other studies, which can be attributed to malnutrition and low health awareness of women in the area [22].

From the association between the severity of anemia and sociodemographic characteristics, and disease shown in Table 3, no significance was found between the severity of anemia and age groups with a P-value of (0.919), which was similar to other studies done in Kenya [23] on the women aged between 40–49 years who had the highest rate of anemia (42% of the sample size). This could be related to low income, educational lack and menstrual disturbance among other factors that could potentially harm health and nutritional status [15]. Also, the occupation showed no significant difference with the severity of anemia with a P-value of 0.699. However, among the illnesses of the participating women, diabetics showed a significant difference between the severity of anemia with a P-value of 0.0004. Whereas blood pressure, bleeding, and haemorrhoids showed no significance between anemia severity with P-values of 0.666, 0.612 and 0.577 respectively. This came down to be compatible with the results of a study in the United Kingdom which states that people with long-term diabetes have a higher rate of anemia [24] and that due to complication of chronic kidney disease occurring at an earlier stage in patients with diabetic nephropathy, erythropoietin deficiency is develops in patients with type 1 diabetes. Since type 2 diabetes is a widespread condition and affects more females than males, it has been observed that the majority of individuals with erythropoietin-deficiency anemia have this condition [25].

**Table 3:** The association of the severity of anemia and some sociodemographic and clinical characteristics among anemic patients (n =156)

Variables	No.	%	Mild		Moderate		Sever		P-value*		
			No	%	No	%	No	%			
Age groups	≤29	47	30	18	38	25	53	4	9	0.919	
	30-39	44	28	16	36	23	52	5	11		
	40-49	65	42	20	31	38	58	7	11		
Occupation	Student	28	18	13	46	13	46	2	7	0.699	
	Housewife	102	65	33	32	58	57	11	11		
	Government employee	26	17	8	31	15	58	3	12		
Disease	Diabetic	Yes	2	1	0	0	2	100	0	0	0.0004**
		No	154	99	54	35	16	10	84	55	
	Blood Pressure	Yes	20	13	8	40	11	55	1	5	0.666
		No	136	87	46	34	75	55	15	11	
	Bleeding	Yes	6	4	1	17	4	67	1	17	0.612
		No	150	96	53	35	82	55	15	10	
	Hemorrhoid	Yes	6	4	3	50	3	50	0	0	0.577
		No	150	96	51	34	83	55	16	11	

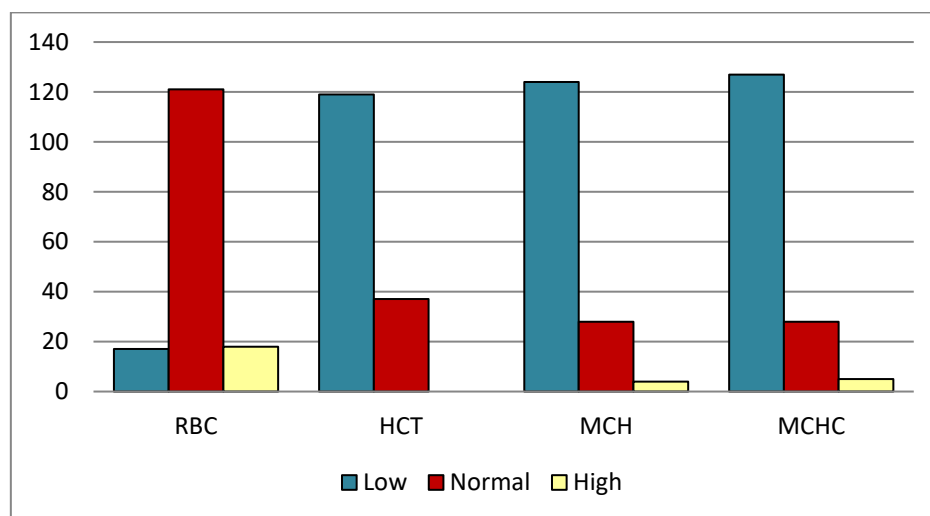
No.: Number of anemic non-pregnant women, \* Chi-square test, \*\* The P-value is significant when its value is <0.05

Table 4 and Figure 2 show that most of the affected women (77.7%) had a normal RBC count. However, they showed low values in Hct (76.3%), MCH (79.5%) and MCHC (81.4%) respectively. Blood indices were found to fall under normal limits, which may be related to inadequate nutrient intake, particularly iron, as well as to prolonged menstruation or other factors such as heavy bleeding, kidney illness and liver disease (cirrhosis) [15, 26]. Some other studies detected a correlation between RBC parameters and metabolic diseases. Increased levels of RBC, Hb, Hct and red blood cells distribution width have been linked to the risk of these disorders. Normal MCV, MCH and MCHC levels have been linked to a lower risk of metabolic disorders [27].

**Table 4 :** Red blood cell profile associated with the anemic patients (n =156)

Red Blood Cell Indices		Number of Anemic Non-pregnant Women	Percentage
RBC	Low	17	10.9
	Normal	121	77.6
	High	18	11.5
	<b>Total</b>	<b>156</b>	<b>100%</b>
Hct	Low	119	76.3
	Normal	37	23.7
	High	0	0
	<b>Total</b>	<b>156</b>	<b>100%</b>
MCH	Low	124	79.5
	Normal	28	17.9
	High	4	2.6
	<b>Total</b>	<b>156</b>	<b>100%</b>
MCHC	Low	127	81.4
	Normal	28	17.9
	High	1	0.6
	<b>Total</b>	<b>156</b>	<b>100%</b>

RBC: Red Blood Cell, Hct: Haematocrit, MCH: Mean Cell Haemoglobin, MCHC: Mean Cell Haemoglobin Concentration

**Figure 2:** Distribution of the red blood cell profile associated with the anemic patients

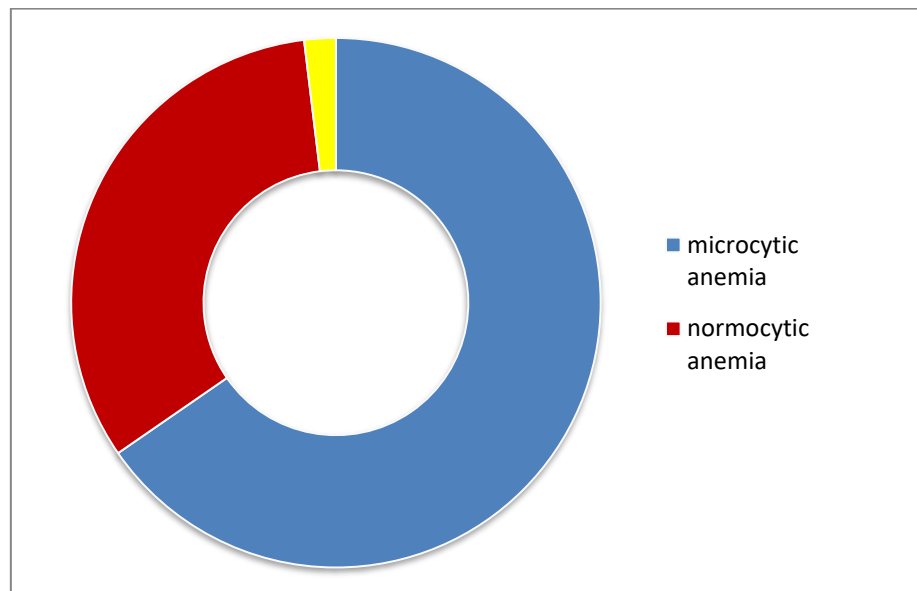
Furthermore, the results showed that 102 (65%) of the samples had microcytic types of anemia with a mean of  $68.26 \pm 7.7$ , 51 (33%) of the sample size had normocytic anemia with a mean of  $86.98 \pm 5.56$ , and only 3 (2%) had macrocytic anemia with a mean of  $103.26 \pm 0.2$  as shown in Table 5 and Figure 3.

**Table 5 :** Types of anemia among the anemic patients (n =156)

Types of anemia	Number of	Percentage	Mean of MCV	SD
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	Anemic Non-pregnant Women		(f1)	
Microcytic	102	65	68.26	7.7
Normocytic	51	33	86.98	5.56
Macrocytic	3	2	103.26	0.2
<b>Total = 156 (100%)</b>				

MCV: Mean Corpuscular Volume



**Figure 3 :** Distribution of types of anemia among anemic patients

Anemia etiologies can be determined and clarified through MCV measurement, including the causes of microcytic, macrocytic and normocytic anemia. The most probable causes of microcytosis are related to iron deficiency anemia, premenopausal, menstrual, or blood loss, with iron deficiency anemia (IDA) being the most frequent cause of microcytosis. Other frequent causes of this form of anemia include thalassemia, sideroblastic and anemia caused by chronic diseases [28]. A study showed that Mexican women with decreased iron nutrition and imbalanced diets contributed to the menstrual cycle, putting these women of normal weight and those with obesity at risk of getting IDA [13, 29]. While normocytosis is associated with different factors such as hemolysis, whether it is intra or extravascular, hypersplenism, posthemorrhagic anemia, and also aplastic anemia, which may be considered normocytic anemia related to myeloid stem cell destruction [30]. Wu *et al.* [31] reported that any of the following conditions could be represented by normocytic anemia: a combination of conditions causing both microcytic and macrocytic anemia; a decrease in the production of normal-sized RBCs, anemia caused by chronic disease or inflammation, and an increase in the destruction or loss of RBCs. However, vitamin B12/folate deficiency or impaired folate use are the most common cause of macrocytosis, as reported in a study done by Nagao and Hirokawa [32] who stated that alcoholism, liver diseases, myelodysplastic syndrome, hypothyroidism and some medications are common causes of macrocytosis. Different geographies and cultures have different common causes of macrocytosis, e.g., 37% of cases in New York were related to medication. Alcoholism (65%) and a lack of vitamin B12 or folate (28%) were the most frequent causes of macrocytic anemia among elderly outpatients in Finland. According to the reports, the prevalence of macrocytosis in the general population is low and ranges between 1.7% and 3.9% [33]. In the study by Al-Faris *et al.* [15] reported that only 0.80% of the samples



were found to be macrocytic, whereas 31.60% were microcytic and 67.60% non-microcytic. The results of our study showed that microcytic anemia is the most prevalent type of anemia compared to normocytic and macrocytic anemia. This finding is similar to the results of the study by Guseibat and Said [34].

#### 4. Conclusion

Anemia is a major world problem with non-pregnant women being more prone to developing this disease around the world. According to the current study, over half of the non-pregnant women suffered from anemia which is considered severe for public health and could be connected to malnutrition and low health awareness among women in the area. The results also showed no significant difference between age, occupation, blood pressure, bleeding, and haemorrhoids with the severity of anemia except for diabetes which revealed a significant association with the severity of anemia. The results revealed that the total anemic non-pregnant women had moderate anemia. Microcytosis anemia which was found to be the most prevalent in the study area may be related to IDA, premenopausal, menstrual or blood loss.

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#### Author Contributions

All authors of this study actively participated throughout the study. These authors equally contributed to the preparation of this work. They also reviewed and approved the submission of the study.

#### Disclosure and Conflict of Interest

The authors declare that they have no conflicts of interest. All experiments followed were under Helsinki Declaration of 1975, as revised in 2000. Informed consent for all human subjects was included in the study.

#### References

- [1] WHO, "Global nutrition targets 2025: anaemia policy brief ", Geneva, Switzerland, Rep. WHO/NMH/NHD/14.4, 2014 [Online], Available: <https://www.who.int/publications/i/item/WHO-NMH-NHD-14.4>.
- [2] WHO, "Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity ", Geneva, Switzerland, Rep. WHO/NMH/NHD/MNM/11.1, 2011 [Online], Available: <https://apps.who.int/iris/handle/10665/85839>.
- [3] A. Lopez, P. Cacoub, I. C. Macdougall, and L. Peyrin-Biroulet, "Iron deficiency anaemia," *The Lancet*, vol. 387, no. 10021, pp. 907-916, 2016.
- [4] E. McLean, M. Cogswell, I. Egli, D. Wojdyla, and B. De Benoist, "Worldwide prevalence of anaemia, WHO vitamin and mineral nutrition information system, 1993–2005," *Public health nutrition*, vol. 12, no. 4, pp. 444-454, 2009.
- [5] N. J. J. Kassebaum, R. Naghavi, M. Wulf, S. K. Johns, N. Lozano, R. Regan, M. Weatherall, D. Chou, D. P. Eisele, T. P. Flaxman, S. R., R. L. Pullan, S. J. Brooker, and C. J. Murray, "A systematic analysis of global anemia burden from 1990 to 2010," *Blood*, vol. 123, no. 5, pp. 615-624, 2014.
- [6] G. A. Stevens, M. M. Finucane, L. M. De-Regil, C. J. Paciorek, S. R. Flaxman, F. Branca, J. P. Peña-Rosas, Z. A. Bhutta, M. Ezzati, and N. I. M. S. Group, "Global, regional, and national trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: a systematic analysis of population-representative data," *The Lancet Global Health*, vol. 1, no. 1, pp. e16-e25, 2013.

- [7] Y. Wu, Ye, Hanfeng, Liu, Jihong, Ma, Qiuyue, Yuan, Yanling and Q. Pang, Liu, Jue, Kong, Cai, Liu, Min, "Prevalence of anemia and sociodemographic characteristics among pregnant and non-pregnant women in southwest China: a longitudinal observational study," *BMC Pregnancy and ChildBirth*, vol. 20, no. 1, pp. 1-10, 2020.
- [8] B. De Benoist, M. Cogswell, I. Egli, and E. McLean, "Worldwide prevalence of anaemia 1993-2005 : WHO global database on anaemia," ed: World Health Organization, 2008 [Online]. Available: <https://apps.who.int/iris/handle/10665/43894>.
- [9] T. Kowsalya and R. Parimalavalli, "Prevalence of overweight/obesity among adolescent girls in Salem District, India," *Indian Journal of Health Sciences and Biomedical Research (KLEU)*, vol. 7, no. 2, pp. 73-77., 2014.
- [10] S. Horton and J. Ross, "Corrigendum to: " The Economics of iron deficiency"[Food Policy 28 (2003) 51-75]," *Food Policy*, vol. 32, no. 1, pp. 141-143, 2007.
- [11] K. L. Harding, V. M. Aguayo, G. Namirembe, and P. Webb, "Determinants of anemia among women and children in Nepal and Pakistan: An analysis of recent national survey data," *Maternal & child nutrition*, vol. 14, p. e12478, 2018.
- [12] Y. Balarajan, U. Ramakrishnan, E. Ozaltin, A. H. Shankar, and S. V. Subramanian, "Anaemia in low-income and middle-income countries," *Lancet*, vol. 378, no. 9809, pp. 2123-2135, 2011.
- [13] B. S. Maner and L. Moosavi, *Mean corpuscular volume: StatPearls [Internet]*, Florida, United States: StatPearls Publishing LLC, Treasure Island, FL, 2019. [Online]. Available: <https://www.ncbi.nlm.nih.gov/books/NBK545275/>
- [14] J. Kaferle and C. E. Strzoda, "Evaluation of macrocytosis," *American family physician*, vol. 79, no. 3, pp. 203-208, 2009.
- [15] N. AlFaris, ALTamimi, J., AlKehayez, N., AlMushawah, F., AlNaeem, A., AlAmri, N., AlMudawah, E., Alsemari, M., Alzahrani, J., Layla Alqahtani, I.I. and Alenazi, W, "Prevalence of anemia and associated risk factors among non-pregnant women in Riyadh, Saudi Arabia: a cross-sectional study," *International journal of general medicine*, vol. 14, pp. 765-777, 2021.
- [16] K. Tunkyi and J. Moodley, "Anemia and pregnancy outcomes: a longitudinal study," *The Journal of Maternal-Fetal & Neonatal Medicine*, vol. 31, no. 19, pp. 2594-2598, 2018.
- [17] D. Kinyoki, A. E. Osgood-Zimmerman, N. V. Bhattacharjee, N. J. Kassebaum, and S. I. Hay, "Anemia prevalence in women of reproductive age in low-and middle-income countries between 2000 and 2018," *Nature medicine*, vol. 27, no. 10, pp. 1761-1782, 2021.
- [18] R. G. Abdulwahid and H. M. Ahmed, "Prevalence and severity of anemia among pregnant women in primary health centers/Erbil City," *Kurdistan Journal of Applied Research*, vol. 2, no. 2, pp. 52-57, 2017.
- [19] E. Akbarpour, Paridar, Yousef, Mohammadi, Zahra, Mard, Ali, L. Danehchin, Abolnezhadian, Farhad, Azadpour, Shima, Rahimi, Zahra, and M. Zamani, Cheraghian, Bahman, "Anemia prevalence, severity, types, and correlates among adult women and men in a multiethnic Iranian population: the Khuzestan Comprehensive Health Study (KCHS)," *BMC Public Health*, vol. 22, no. 1, pp. 1-13, 2022.
- [20] S. Z. Hyder, L.-Å. Persson, A. Chowdhury, and E.-C. EkstroÈm, "Anaemia among non-pregnant women in rural Bangladesh," *Public health nutrition*, vol. 4, no. 1, pp. 79-83, 2001.
- [21] W. Gardner and N. Kassebaum, "Global, regional, and national prevalence of anemia and its causes in 204 countries and territories, 1990–2019," *Current Developments in Nutrition*, vol. 4, no. 2, pp. 830-830, 2020.
- [22] A. S. Muhammad, M. Latif, M. Khan, M. H. Siddiqui, K. Mohabbat, and M. Azmat, "Prevalence and Risk Factors of Anemia among Non-pregnant Women of Childbearing Age," *Journal of Allama Iqbal Medical College*, vol. 18, pp. 374-379, 2020.
- [23] M. C. Siteti, S. D. Namasaka, O. P. Ariya, S. D. Injete, and W. A. Wanyonyi, "Anaemia in pregnancy: Prevalence and possible risk factors in Kakamega County, Kenya," *Science journal of public health*, vol. 2, no. 3, pp. 216-222, 2014.
- [24] O. Adetunji, H. Mani, A. Olujohungbe, J. Ronald, C. Morgan, and G. Gill, "Prevalence and characteristics of anaemia in diabetes," *Practical Diabetes International*, vol. 25 pp. 110-113, 2008
- [25] S. Thomas and M. Rampersad, "Anaemia in diabetes," *Acta diabetologica*, vol. 41, no. 1, pp. s13-s17, 2004.

- [26] K. Pala and N. Dundar, "Prevalence & risk factors of anaemia among women of reproductive age in Bursa, Turkey," *Indian Journal of Medical Research*, vol. 128, no. 3, pp. 282-286, 2008.
- [27] K. G. Nebeck, B. Lemma, S. Berhane, Y. Bekele, T. Khali, A., Y. Haddis, and M. A. Williams, "Hematological parameters and metabolic syndrome: findings from an occupational cohort in Ethiopia," *Diabetes & Metabolic Syndrome*, vol. 6, no. 1, pp. 22-27, 2012.
- [28] M. Sirdah, I. Tarazi, E. Al Najjar, and R. Al Haddad, "Evaluation of the diagnostic reliability of different RBC indices and formulas in the differentiation of the beta-thalassaemia minor from iron deficiency in Palestinian population," *International Journal of Laboratory Hematology*, vol. 30, no. 4, pp. 324-330, 2008.
- [29] A. Tijerina-Sáenz, N. E. Martínez-Garza, E. Ramírez-López, E. Solís-Pérez, and A. Z. Martínez-Báez, "Iron status and dietary intakes of iron in normal-weight and obese young Mexican women," *Nutricion hospitalaria*, vol. 31, no. 6, pp. 2412-2418, 2015.
- [30] M. J. Koury and M. Rhodes, "How to approach chronic anemia," *Hematology 2010, the American Society of Hematology Education Program Book*, vol. 2012, no. 1, pp. 183-190, 2012.
- [31] Y.-H. Wu, Y.-T. Jin, Y.-C. Wu, J. Y.-F. Chang, C.-P. Chiang, and A. Sun, "Anemia, hematinic deficiencies, hyperhomocysteinemia, and gastric parietal cell antibody positivity in burning mouth syndrome patients with normocytosis," *Journal of Dental Sciences*, vol. 17, no. 1, pp. 35-41, 2022.
- [32] T. Nagao and M. Hirokawa, "Diagnosis and treatment of macrocytic anemias in adults," *Journal of general and family medicine*, vol. 18, no. 5, pp. 200-204, 2017.
- [33] F. Aslinia, J. J. Mazza, and S. H. Yale, "Megaloblastic anemia and other causes of macrocytosis," *Clinical Medicin & Research*, vol. 4, no. 3, pp. 236-241, 2006.
- [34] T. A. Guseibat and M. M. said, "A comparative study on the prevalence of microcytic anemia and associated age of anemic patients from Benghazi city," *Journal of Pure & Applied Sciences*, vol. 19, no. 1, pp. 27-32, 2020.